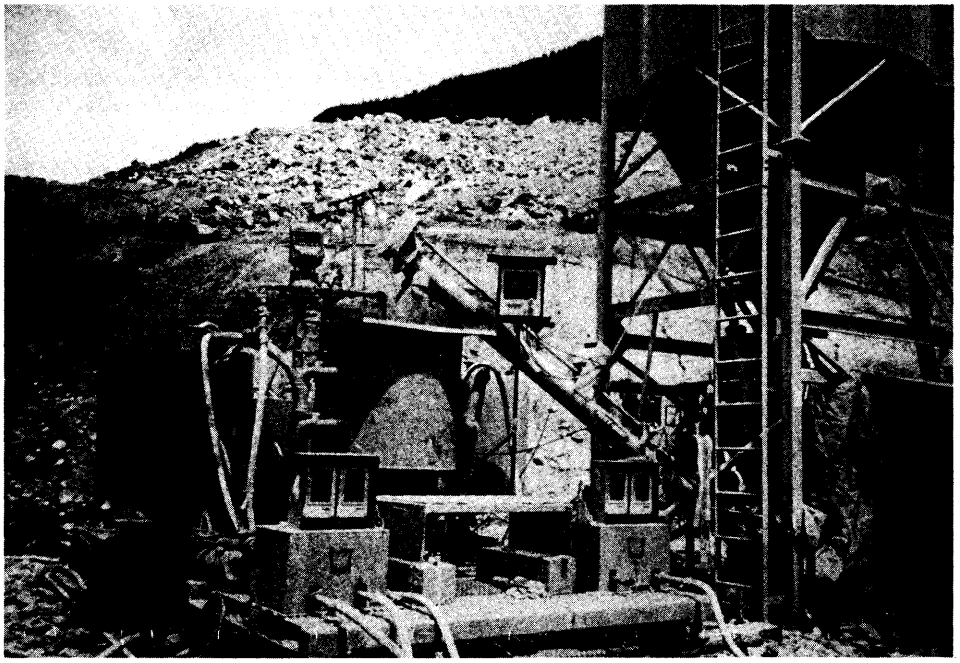
REMR TECHNICAL NOTE GT-RR-1.1

INJECTABILITY OF GROUTS CONTAINING MICROFINE CEMENT AND PORTLAND CEMENT WITH A HIGH-RANGE WATER-REDUCING AGENT



PURPOSE: To provide information on the injectability of portland-cement and microfine-cement grouts and on a preliminary evaluation of the use of a high-range water-reducing agent in grout.

APPLICATION: The grouting of foundations which are permeable but have very small fractures or apertures requires the use of a grout capable of penetrating these small voids. When the grout is able to penetrate the foundation voids, it can be used for consolidation, curtain grouting, and deep foundation grouting. Cement grouts can be used to decrease the permeability and increase the shear and compressive strengths of the foundation material.

ADVANTAGES: Grouts made with microfine cement and grouts made with portland cement and a high-range water-reducing agent are able to penetrate finer fracture systems or smaller apertures than grouts made with portland cement alone. Cementitious grouts cause less pollution of underground waters and soils than most chemical grouts.

LIMITATIONS: Grouts containing high-range water-reducing agents should be used promptly after mixing to prevent the loss of the beneficial but time-dependent properties of the water-reducing agent. The properties of

portland-cement grout with a water-reducing agent are very sensitive to the amount of water-reducing agent in the mixture, so care must be taken when monitoring and measuring the addition of high-range water reducers to grout mixtures. Grouts made with microfine cement are significantly more expensive than conventional portland-cement grouts.

EVALUATION: Under a cooperative program between the US Bureau of Reclamation and the Corps of Engineers, a series of tests is being performed to better define the grout properties and injectability of microfine-cement grouts and of portland-cement grouts with a high-range water reducer. In these tests, various grout mixtures are being pumped into an 8-in.-diameter by 35-in.-tall cylinder filled with sands of varying sieve sizes. Because of limitations of the test apparatus, grout pressures are limited to a maximum of 30 psi. Actual pressures used are in the range 0 to 5 psi. When grout pressures exceed this range, blockages occur and grout cannot be pumped without lifting the sand column. It has been found that microfine-cement grouts with water-cement (W/C) ratios (by volume) of 1.0 and higher can be injected uniformly into a No. 50 sand (sand passing a No. 30 sieve, but retained on a No. 50 sieve) and that a grout with a 0.8 to 1.0 W/C ratio can be injected into a No. 30 sand (sand passing a No. 16 sieve, but retained on a No. 30 sieve). Conventional portland-cement grouts with W/C ratios (by volume) of 2.0 and higher can be injected into a No. 30 sieve sand. When a high-range water-reducing agent (WRDA-19, manufactured by W. R. Grace Company) in a concentration of 4 percent (by weight of cement) is added to the conventional portland-cement mixtures, the W/C ratio can be reduced to 0.8 and the grout can still be injected into a No. 30 sieve sand. These tests are not being performed to determine whether the various grout mixtures can be used to grout naturally occurring sandy foundation materials. The sieved sands have been chosen for grout injection only to provide a reproducible medium useful in defining the relative injectability of the grouts being tested. All microfine-cement grouts used in this study contain 1 percent (by weight of cement) of an NS-200 dispersant as recommended and supplied by the manufacturer.

TECHNICAL DATA FROM MICROFINE CEMENT MANUFACTURER: Figures 1 and 2 present technical data developed by the manufacturer of the microfine cement used in the evaluation described herein. It should be noted that the cement grout depicted in Figure 2 does not contain a water-reducing agent. Data provided by manufacturer have not been verified by the Corps of Engineers or the Bureau of Reclamation. Other available data on the microfine cement and the dispersant used with it are listed below.

a. MC-500 Microfine Cement:

1. Effective date: September 1, 1985.

2. Terms: Net 30 days on approved credit or cash with order.

3. Freight: Collect.

4. Shipping point: Baltimore, MD; Ventura, CA; Chicago, IL.

5. Packaging: 20-kg (44-lb) plastic bags;
50 bags, 1,000 kg (2,205 lb), per pallet.

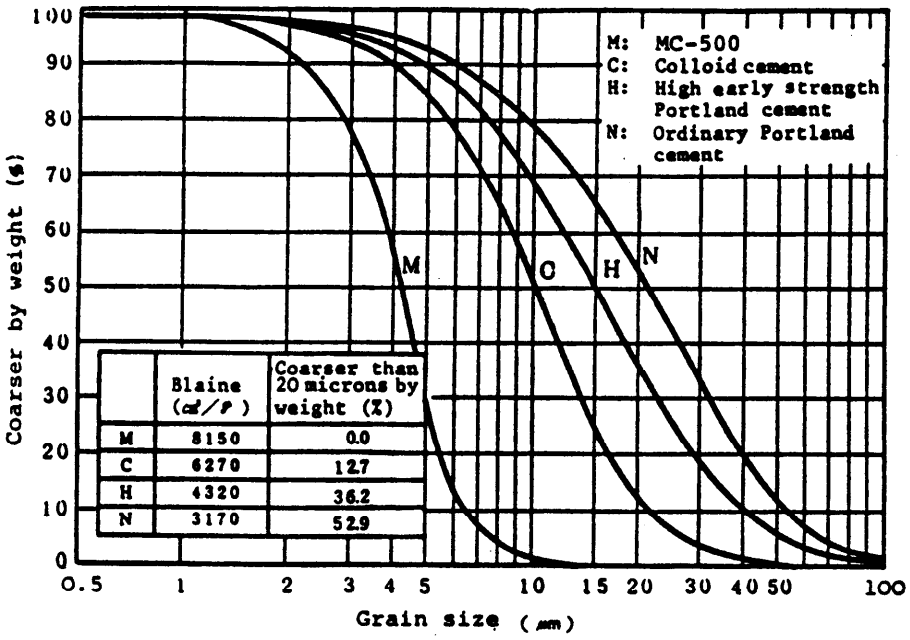


Figure 1. Gradation curves for MC-500 and three other cements.

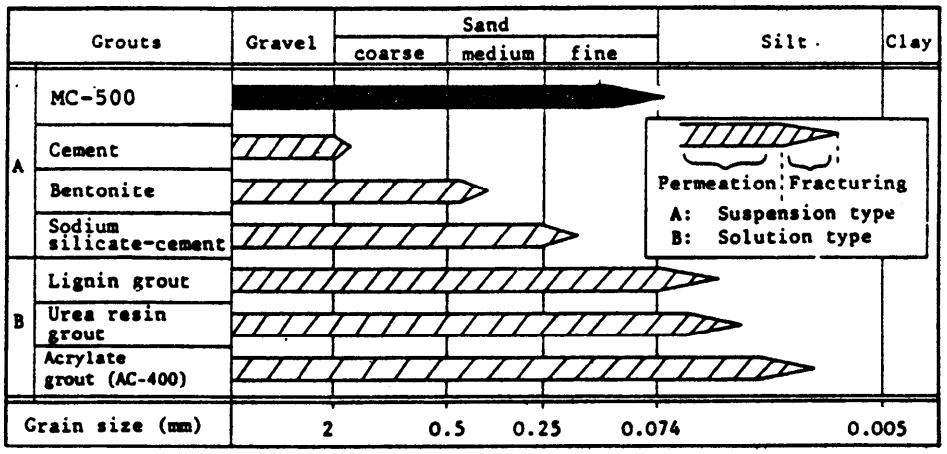


Figure 2. Comparison of permeation of MC-500 microfine-cement, silicate, and chemical grouts.

6. Technical references: Geochemical Corporation's MC-500 technical note, product bulletin, and specification; reports of the American Society of Civil Engineers and the American Concrete Institute.

7. Cost of individual shipments (US dollars):

	Number of Bags				
	50-299	300-599	600-999	1,000-2,999	3,000-up
Net weight, kg	1,000-5,980	6,000-11,980	12,000-19,980	20,000-59,980	60,000-up
Cost, $/kg	$1.30	$1.20	$1.10	$1.00	$0.90

b. NS-200 Dispersant:

1. Packaging: 20-kg (44-lb) plastic bag in can.

2. Technical reference: Geochemical Corporation's MC-500 technical note.

3. Quantity: 1.0 percent of MC-500 microfine cement.

4. Costs of individual shipments (US dollars):

	Number of Cans				
	1-4	5-6	7-10	11-29	30-up
Net weight, kg	20-80	100-120	140-200	220-580	600-up
Cost, $/kg	$1.40	$1.30	$1.20	$1.10	$1.00

EQUIPMENT REQUIREMENTS: Microfine-cement grout and portland-cement grout containing a high-range water-reducing agent should be mixed with a high-speed centrifugal grout mixer.

GROUT SELECTION: The following procedure is recommended for grout selection:

a. Conduct water pressure test of zone to be grouted to determine whether cement grouting is feasible.

b. If the zone is determined potentially groutable but will not accept portland-cement grout, grouting of a trial hole, not contaminated with portland-cement grout, should be attempted with portland-cement grout containing a high-range water-reducing agent.

c. Grouting with microfine-cement grout should be attempted if zone will not accept portland-cement grout with a high-range water-reducing admixture. Microfine-cement grouting should be attempted in a hole not contaminated with other grout mixtures.

AVAILABILITY: The materials that have been used in the evaluation described herein are available from the sources listed below.

a. Microfine Cement MC-500 and NS-200 Dispersant: Geochemical Corp., 162 Spencer Place, Ridgewood, NJ 97450.

b. High-Range Water-Reducing Agent WRDA-19: W. R. Grace Company, Construction-Products Division, 62 Whittermore Ave., Cambridge, MA 02140.

c. Type II Portland cement: Laboratory blend by the US Bureau of Reclamation.